III. *The Portugal Kales.*—We have two sorts of kales that have the extensive rib-system and the general aspect of the Portugal cabbage. These are the *Chou Brocoli* and the *chou frise de mosbach* of Vilmorin. I must consider these as bearing the same relation to the Portugal cabbage that our kales bear to the heading cabbages. Of their history I have ascertained nothing.

ON CERTAIN FACTORS OF EVOLUTION.[1]

BY ALPHEUS. S. PACKARD.

SO far as we are aware, Lamarck was the first naturalist to refer the atrophy of eyes and loss of vision to disuse from a life in darkness, as may be seen by the following extract from the chapter in his Philosophie Zoologique, entitled "De l'influence des circonstances sur les actions et les habitudes des animaux, et de celle des actions et des habitudes de ces corps vivans, comme causes qui modifient leur organisation et leurs parties." This work appeared in 1809, many years before the discovery of blind animals peculiar to caves.

"Des yeux à la tête sont le propre d'un grand nombre d'animaux divers, et font essentiellement partie du plan d'organisation des vertébrés. Déjà néanmoins la taupe, qui, par ses habitudes, fait très-peu d'usage de la vue, n'a que des yeux très-petits, et à peine apparens, parce qu'elle exerce très-peu cet organe.

"L'Aspalax d'Olivier (Voyage en Égypte et en Perse, II, pl. 28, fig. 2), qui vit sous terre comme la taupe, et qui vraisemblablement s'expose encore moins qu'elle à la lumière du jour, a totalement perdu l'usage de la vue; aussi n'offre-t-il plus que des vestiges de l'organe qui en est le siège; et encore ces vestiges sont tout-à-fait cachés sous la peau et sous quelques autres parties qui les recouvrent, et ne laissent plus le moindre accès à la lumière.

"Le protée, reptile aquatique, voisin des salamandres par ses rapports, et qui habite dans des cavités profondes et obscures qui

[1] From advance sheets of an essay on Cave Animals of North America. Mem. Nat. Acad. Sciences.

sont sous les eaux, n'a plus, comme l'Aspalax, que des vestiges de l'organe de la vue; vestiges qui sont couverts et cachés de la même manière.

"Voici une considération décisive, relativement à la question que j'agite actuellement.

"La lumière ne pénètre point partout; conséquemment, les animaux qui vivent habituellement dans les lieux où elle n'arrive pas, manquent d'occasion d'exercer l'organe de la vue, si la nature les en a munis. Or, les animaux qui font partie d'un plan d'organisation, dans lequel les yeux entrent nécessairement, en ont dû avoir dans leur origine. Cependant puisqu'on en trouve parmi eux qui sont privés de l'usage de cet organe, et qui n'en ont plus que des vestiges cachés et recouverts, il devient évident que l'appauvrissement et la disparition même de l'organe dont il s'agit sont des résultats, pour cet organe, d'un défaut constant d'exercice (2d edit., i, p. 241)."

In his "Origin of Species" Darwin, after claiming that "natural selection would constantly aid the effects of disuse" in the case of moles and the burrowing rodents, then remarks in regard to cave animals: "As it is difficult to imagine that eyes, though useless, could be in any way injurious to animals living in darkness, I attribute their loss wholly to disuse" (p. 142). On the next page he writes: "By the time an animal had reached, after numberless generations, the deepest recesses, disuse will on this view have more or less perfectly obliterated its eyes, and natural selection will often have effected other changes, such as an increase in the length of the antennæ or palpi, as a compensation for blindness."

It may be that the struggle for existence goes on even in the darkness of caves, and that the "fittest" of the limited population survive by reason of their adaptation to their untoward surroundings. How adverse to life of any sort caves are may be realized when we consider that only the lowest plants, and only a very few of those, live in caves. Without doubt the germs of fungi and the seeds of the higher plants are carried into the caves by freshets in subterranean streams and through sink-holes. Why, in spite of the darkness, we should not find more fungi even, and why one or two of the *green* algæ should not flourish in the pools and brooks of caves, or why the seeds of the higher plants should not germi-

nate, even if the plants do not bear fruit, can only be explained by the absence of light; and perhaps this is an important cause of the absence of all plant life in the ocean below a depth of about 300 to 500 fathoms. Certainly there are ample means for the colonization of caves by vegetables; the temperature, moisture, and inorganic food are more favorable than the sum total of conditions on alpine summits or in the high polar regions, or in hot springs.

Animal life can apparently withstand greater physical obstacles than vegetable. As regards the struggle for existence, it possibly exists to a limited extent in cave animals. There is probably not enough vegetable or decayed animal food for all the animals, and some may die of hunger. The carnivorous beetles and Arachnida perhaps have a less favorable chance to obtain living food than the Crustacea, for the blind crayfish have a tolerable abundance of food in the Cæcidotæa, perhaps the most abundant form found in caves containing underground waters.

We may, with Darwin, for convenience, use the phrase "natural selection" to express the process by which the cave fauna was produced, but such a term to our mind expresses rather the result of a series of causes than a *vera causa* in itself. There is of course no doubt but that many animals carried by different means into caves cannot thrive there, and consequently die. It is only those which have been able, by certain peculiarities of their life in the upper world allied to cave existence, to adapt themselves to cave conditions which permanently breed there. Such forms, it is convenient to say, have been by nature selected and are successful in colonizing the darkest and most forbidding and apparently hopeless corners in the earth's crust. But such a phrase as "natural selection," we repeat, does not to our mind definitely bring before us the actual working causes of the evolution of these cave organisms, and no one cause can apparently account for such a result. There is rather a complex assemblage of physical causes, all working together, to secure a harmonious result. The most important and potent of these causes, when we study them under such appreciable, because so extraordinary, conditions as the physical features of cave existence, would seem to be the following:

1. Change in environment from light, even partial, to twilight or total darkness, and involving diminution of food, and compensation for the loss of certain organs by the hypertrophy of others.

2. Disuse of certain organs.

3. Adaptation, enabling the more plastic forms to survive and perpetuate their stock.

4. Isolation, preventing intercrossing with out-of-door forms, thus insuring the permanency of the new varieties, species, or genera.

5. Heredity, operating to secure for the future the permanence of the newly originated forms as long as the physical conditions remain the same.

Natural selection perhaps expresses the total result of the working of these five factors rather than being an efficient cause in itself, or at least constitutes the last term in a series of causes. Hence Lamarckism in a modern form, or, as we have termed it, Neo-lamarckism, seems to us to be nearer the truth than Darwinism proper or "natural selection."

The factors of organic evolution such as we have mentioned are, of course, theoretical, and the critic or unbeliever in a theory of descent demands facts in demonstration of the truth of the derivation of cave animals. Of the facts we have ourselves observed, or which have been observed by others, we will briefly summarize:—

1. The variations in *Pseudotremia cavernarum* and *Tomocerus plumbeus*, found living near the entrance of caves in partial daylight.

2. The bleaching of Polydesmus and Machilis found living in small caves; the blindness of Neotoma, or the wood-rat of Mammoth Cave; of fish found in wells and subterranean streams; the atrophy of the mole's optic nerves induced in one generation.

3. The larger size of the eyes of the young than in the adult Troglocaris of Europe, and the blind crayfish of American caves; Semper's history of the atrophy of eyes in the parasitic Pinnotheres; eyes of *Gammarus pulex* affected after living in darkness; the eyes of Gammaridæ in Lake Baikal becoming smaller the deeper they live; the instability in the eyes of Cæcidotæa.

In a small cave near White's Cave, and at a point about sixty feet from the mouth, occurred a salamander (*Spelerpes longicaudatus* Green), which was apparently bleached, being nearly white, with dark brown blotches. The common *Cambarus bartonii* occurs somewhat bleached in Mammoth Cave, and this may not be the result

of inheritance, but occurs in young hatched without the cave, and afterwards carried in so as not to be exposed to the light, the shell remaining pale as in the very young. Perfectly white, bleached specimens of the common *Polydesmus granulatus* Say, occurred in Indian Cave. The pale variety of *Tomocerus plumbeus* is possibly the product of a single or at least very few generations; the white and blind Porcellio found by Mr. Hubbard in Little Wyandotte Cave, though possibly a true cave form, has not yet been found elsewhere, and may have been the young of a normal, epigean species. But the most striking instance is the bleached specimen of *Asellus communis* from Lost River, referred to on pp. 15 and 33, which, though white, had eyes of normal size: there is good reason to suppose that these specimens were hatched in epigean waters, and that being carried into Lost River when young, the pigment in its skin, owing to absence of light, had failed to assume its normal dark color.

A parallel case is that mentioned by R. Schneider[1]:—

"The author gives an account of the subterranean variety of *Gammarus pulex* which is found at Clausthal. The first point of interest is its pale color, pigment being so completely absent from its body that it is milk-white and transparent; even the fat-cells, which are intensely red or orange-yellow in the ordinary *G. pulex*, are quite white. In the second place, the eye is not normally developed, but is in the first stage of reduction; the crystalline cones show signs of degeneration, and the whole eye exhibits that 'megalophthalmy,' or proportionately greater size which is often the first indication of loss. The pigment has also begun to be reduced, and is of a dirty black, instead of a brownish color. The anterior pair of antennæ exhibits elongation, owing to the increase in the number of the joints.

"There is, as compared with the ordinary forms, a considerable increase in the amount of calcareous deposits; and there is always a considerable amount of iron-oxide in the contents of the intestine, whence the iron makes its way to various parts of the body.

"Fries[2] suggests that experiments should be made on the effects

[1] Unterirdische Gammarus von Clausthal, P. B. Ak. Berlin, 1885, p. 1087; also, Abh. z. Programm k. Real-Gymnasiums Berlin, Ostern; Abstr. in Journal Roy. Micr. Soc. (2), vi., p. 243.

[2] Zool. Anzeiger, Aug., 1879, pp. 36, 37.

of rearing normal, eyed Gammari in darkness, and refers to Humbert's statement that in the greater depths of Lake Baikal, with an increase in depth of their habitat, there is an increasing lack of development of the eyes in some Gammaridæ. Fries also states that he himself had previously observed a decrease in the pigment of the eyes in young examples of *Gammarus pulex* living in darkness."

Here should be cited the observations of Anton Stecker, who states that Chermes, usually said to be eyeless, has rudimentary eyes, represented by clear, somewhat transparent spots, the chitin forming them being devoid of the granulations covering the rest of the shield.

"Each cornea is supplied by a large and well-developed optic nerve, proceeding from an optic ganglion in connection with the brain. But the layer of crystalline rods was wholly absent. About 30 to 35 per cent. of the specimens of *Chermes cimicoides* examined possessed these eye-spots; in the remaining 65 to 70 per cent. they were absent, as well as the optic nerves; while there was only one, or even no recognizable rudiment of an optic ganglion. He also found that the offspring of parents, both of which had eyes, were themselves provided with them; but that if either the father or the mother were blind, the young were also blind, having at most a feeble indication of optic lobes. Dr. Stecker considers this a most instructive case of the gradual atrophy of an organ by disuse owing to the influence of changed conditions. There can be little doubt that the ancestors of Chermes possessed well-developed eyes; the first steps in the retrogressive process was the loss of the cornea and cones, the optic nerve and ganglion remaining after the true percipient apparatus had gone."[1]

Here is a fertile field for careful and long-continued observations on animals reared in different degrees of darkness. Such experiments will afford a crucial test of the theory of rapid evolution of genera and species due to sudden changes in the environment.

It is evident that physiological experiments are needed as well as embryological studies, to throw further light on the origin of cave animals. The blind-fish, blind crayfish, and Cæcidotæa,

[1] Morp. Jahrbuch, iv., 279, 1878; Journ. Roy. Micr. Soc., ii., 146, 1879.

which might be reared in dark cellars, should be observed for a series of generations, to ascertain whether by breeding the eyes cannot be restored, and the species by artificial means be induced to revert to its ancestral type. The embryology of the cave beetles, with or without rudimentary eyes, of the eyeless spiders and of Myriapods, of the Cæcidotæa, and of the blind crayfish and blind-fish should be carefully worked out as regards the presence of organs of vision in a rudimentary state, though we should hardly expect to find rudimentary eyes in Anophthalmus when larva and pupa do not possess them.

Isolation as a Factor in the Origin of Cave Animals.—When any cave, such as Mammoth or Wyandotte, etc., is once colonized by emigrants from the upper world, and the colonists becoming adapted to the new conditions environing them, have lost their eye-sight, or even all traces of eyes, and the new forms thus established begin to breed true to their recently acquired characteristics, it is obvious that this process of in-and-in breeding will continue as long as the new forms live in total darkness and are isolated from the allied forms or their eyed ancestors of the upper world of light. Though a subordinate factor, isolation is certainly of no little importance in securing the stability of the new species and genera. It is evident that if no stragglers from the upper world, as species of Trechus to interbreed with the cave Anophthalmi, species of Choleva to cross with Adelops or Bathyscia, or species of Ceuthophilus to mix with the true cave Ceuthophili, or species of Myriapods or Arachnida to intercross with the cave forms, then the latter will tend to remain as fixed as we now find them to be. In the case of the crayfish of Mammoth Cave, the normal *Cambarus bartonii*, introduced at times of heavy rains or freshets into the cave, is not seldom found living in company with *Orconectes pellucidus*, the blind form, but belonging to a different section of the genus as regards the shape of its gonopods or first male abdominal appendages, and being of much larger size, it is probably incapable of fertilizing the eggs of the blind form, even if the latter, timid and sensitive to the least disturbance of the water, should allow itself to be approached by the larger-eyed form. It is also probable that *Cœcidotœa stygia* is seldom, if ever, brought in contact with *Asellus communis*, which abounds in the pools and streams through-

out the cave region. I have never found a stray Asellus even partly bleached and with diminished eyes in any caves, nor seen such specimens in collections made by others, though they may yet be found. Whether living in caves or wells fed by subterranean streams, the bleached, eyeless, or nearly eyeless, forms breed true to their type, and show no signs of intercrossing with lucophilous forms.

Should, however, these cave forms be placed in such circumstances as to be able to mix or intercross with their epigæan allies, which are in all probability the very species to which they owe their origin, there would with little doubt be a constant tendency to revert to the ancestral eyed forms, and we should constantly find certain individuals with visual organs better developed, and with a darker integument, serving as connecting links. Such links may have been common enough when the caves were first formed and colonized, and in some species, as *Pseudotremia cavernarum*, they frequently occur at the present time, but, as a rule, owing to long isolation or seclusion, and the consequent impossibility of intercrossing, they are now rare.

But as circumstances are now, the total darkness, the temperature, the degree of dryness or the moisture, and other physical conditions remaining the same, the cave fauna is almost completely isolated from that of the upper world; indeed, far more so than the deep-sea fauna of the ocean or of lakes, or the faunas of deserts or of the polar regions, or the alpine inhabitants of lofty mountain summits. We thus realize that isolation may be a not unimportant factor in securing permanence of type, after the typical characters have once been established through adaptation and heredity.

After reflecting upon the influence of isolation upon cave animals as securing permanence of varietal, specific, and generic characters, one is led to realize as never before the importance of geographical isolation in general as a factor in preventing variation after the organisms have once become adapted to their peculiar environment, whether dependent on temperature, soil, humidity, or dryness, the absence of light, or any other appreciable characteristic in their surroundings. We know also that the existing desert, deep-sea, and polar faunas are the product of Quaternary times; that they were nearly contemporaneous in origin with the cave faunæ,

though the deep-sea faunæ may date from the cretaceous period. Finally, I may quote from Darwin's "Origin of Species" the following extract, which applies (though he did not make it applicable to any special case) with peculiar force to cave fauna: "If, however, an isolated area be very small, either from being surrounded by barriers, or from having very peculiar physical conditions, the total number of the inhabitants will be small, and this will retard the production of new species through natural selection, by decreasing the chances of the appearance of favorable individual differences" (Fifth edition, New York, p. 105).

Heredity.—The action of this all-powerful factor in evolution is as constant in the underground world, and as difficult to comprehend in considering cave life, as that of the upper regions. It begins to act, of course, with the earliest generations, and continues to act with, so to speak, increasing force and precision as time goes on and the characteristics induced by a life in total darkness becomes more and more fixed.

It is evident that heredity has acted longest in those insects, such as the species of Anophthalmus and Adelops, whose larvæ are lacking in all traces of eyes and optic nerves and lobes. Heredity has here acted with unabated force throughout every stage of the metamorphosis; and, it will be a matter of great interest to ascertain whether any traces of the eyes may be met with in the embryo of these forms.

On the other hand, in those Arthropods in which the brain and optic nerves have persisted, with rudiments of the eyes (*e.g.*, Orconectes), where the eyes are larger in the young, it would seem as if heredity had been acting through a shorter period, and consequently, so to speak, with less momentum.

In the case of Machærites, in which the females only of certain species are said to be blind, while the males have well-developed eyes, we have an apparent exception to the continuous action of heredity; an exception paralleled, however, by animals living in the upper world, such as Termes, whose workers and soldiers are eyeless, though the males and females are eyed. They perhaps are twilight species rather than inhabitants of totally dark localities in caves, and those living in twilight may intercross with those

inhabiting the darker regions, and such a case as this, remarkable as it would appear, does not affect the general rule, that animals living in total darkness and never living in twilight, nor intercrossing with twilight forms, are eyeless, or at least blind.

Nor does the case of Hadenœcus, the cave cricket, with well-developed eyes and brains, affect the argument; for this is essentially a twilight form, though migrating to regions of total darkness and abounding there. The same may be said of the cave species of Ceuthophilus. A parallel case may be that of Chologaster as compared with Amblyopsis, the former living out of caves in ditches as well as in wells and caves.

Judging by the following statement, so eminent a naturalist as Professor Semper denies that heredity acts in the case of the mole. He says:

"This almost total blindness in the mole is the result solely of complete degeneration of the optic nerve, so that the images which are probably formed in the eye itself can never be transmitted to the animal's consciousness. Occasionally, however, the mole even can see a little, for it has been found that both optic nerves are not always degenerate in the same individual, so that one eye may remain in communication with the brain while the other has no connection with it. In the embryo of the mole, however, and without exception, both eyes are originally connected with the brain by well-developed optic nerves, and so theoretically efficient. This may indeed be regarded as a perfectly conclusive proof that the blind mole is descended from progenitors that could see; it would seem, too, to prove that the blindness of the fully grown animal is the result not of inheritance, but of the directly injurious effects of darkness on the optic nerve in each individual." [1]

It may be objected, however, that each mole certainly inherits a tendency to weakness and atrophy of the optic nerves, just as the children of consumptive or strumous parents inherit a tendency to those diseases, and that when the conditions are favorable the disease manifests itself. We know there have been many generations of blind or partially blind moles, and it would be strange if heredity did not at a certain age act in such a case, and would not for at least a few generations even if the moles were kept out of the dark-

[1] Animal Life, etc., pp. 79, 80.

ness. We have in the atrophy of the optic nerves of the mole a parallel case in the blind Myriapod *Pseudotremia cavernarum*, where the eyes survive but the optic nerve is wanting, as also in a less marked degree in some of the individuals of *Cœcidotœa stygia*.

The study of the conditions of existence in caves is of special value, because such conditions are so unusual and abnormal and the results upon certain organs so easily appreciated. It is by a study of life under unusual conditions that the attention is aroused and interest is excited, and after acquiring experience in dealing with the more palpable, because somewhat abnormal, circumstances under which organisms exist, we can then more easily observe the effects of changes of ordinary conditions upon the organism.

From a study of cave life, of organisms existing in saline and in heated waters, of plants and animals exposed to great cold in alpine or polar regions, of those living in hot, dry deserts, we can turn to an examination of the results of adaptation to a parasitic mode of life. The strange modifications of form, owing to disuse, in internal as well as external parasites of different orders and classes, the change of host necessitated, and the intensity of the struggle for existence in animals living under such exceptional conditions, embryology proving that they have arisen from animals of normal organization,—such studies as these are of fundamental importance in a discussion of the origin of species and higher categories. Moreover, the study of the results of the incoming and cessation of the Glacial epoch, the effects on life arising from the elevation and depression of the land, involving not only change of land surfaces, but a change of climate,—it is by a study of such marked changes as these in the conditions of life that we are prepared to examine the more subtle causes of variation throughout the organic world in general.

After the foregoing pages were written we read with much interest Mr. Herbert Spencer's recent essays entitled "The Factors of Organic Evolution."[1] While that author, it appears to us, lays too great stress on Dr. Erasmus Darwin's views, as compared with Lamarck's; the author of the Philosophie Zoologique having been a professional botanist and zoologist as well as a naturalist of the

[1] New York, 1887, reprinted from the Nineteenth Century for April and May, 1886.

first rank, it is noteworthy that he sees clearly that natural selection is not the sole factor in organic evolution, as will be seen by the general drift of his essays, by his quoting with approval Huxley's significant remark that "Science commits suicide when it adopts a creed," and by the following extracts from his own essays :—

"But now, recognizing in full this process brought into clear view by Mr. Darwin, and traced out by him with so much care and skill, can we conclude that, taken alone, it accounts for organic evolution? Has the natural selection of favorable variations been the sole factor? On critically examining the evidence we shall find reason to think that it by no means explains all that has to be explained" (p. 9).

During that earlier period, when he was discovering the multitudinous cases in which his own hypothesis afforded solutions, and simultaneously observing how utterly futile in these multitudinous cases was the hypothesis propounded by his grandfather and Lamarck, Mr. Darwin was, not unnaturally, almost betrayed into the belief that the one is all-sufficient and the other inoperative.[1] But in the mind of one usually so candid and ever open to more evidence there naturally came a reaction. The inheritance of functionally produced modifications, which, judging by the passage quoted above concerning the views of these earlier inquirers, would seem to have been at one time denied, but which, as we have seen, was always to some extent recognized, came to be recognized more and more, and deliberately included as a factor of importance.

In his references to the works and opinions of other naturalists Mr. Spencer confines himself almost exclusively to those of Mr. Darwin, who always opposed, and, it must be confessed, with less than his usual candor and fairness, the views of Lamarck as to the influence of a change in the environment upon organisms.[2]

It seems singular that Mr. Spencer should not be acquainted

[1] It is surprising to read in Darwin's Life, by his son, the expressions showing his lack of appreciation of Lamarck and his work; Darwin seems from the first to have been strongly prejudiced against Lamarck's views, and never to have done them justice.

[2] In the Origin of Species (p. xiv., note) Darwin writes, as quoted by Spencer: "It is curious how largely my grandfather, Dr. Erasmus Darwin, anticipated the views and erroneous grounds of opinion of Lamarck in his 'Zoonomia' (vol. i., pp. 500–510), published in 1794" (p. 29).

with the work of those who have brought together certain facts bearing on the physical factors of evolution.[1] The principal factors referred to by Mr. Spencer are use and disuse and the influence of light. In one place he does in concrete language sum up these agencies as follows:—

"The growth of a thing is effected by the joint operation of certain forces on certain materials; and when it dwindles there is either a lack of some materials or the forces co-operate in a way different from that which produces growth. . . . . That is to say, growth, variation, survival, death, if they are to be reduced to the forms in which physical science can recognize them, must be expressed as effects of agencies definitely conceived—mechanical forces—light, heat, chemical affinity, etc." (pp. 39, 40).

On page 70 Mr. Spencer remarks:—

"But nevertheless, as we here see, natural selection could operate only under subjection. It could do no more than take advantage of those structural changes which the medium and its contents initiated."

Again, on page 73, Spencer suggests that natural selection, in order to act, must have had a limited number of organisms upon which to operate.[2] As he remarks:—

"Though natural selection must have become increasingly active when once it had got a start, yet the differentiating action of the medium never ceased to be a co-operator in the development of these first animals and plants."

[1] In the writer's Introduction to the Standard Natural History, 1885, under the head of Evolution (pp. 1 and lxii.), he has endeavored to bring together references to the different authors who have insisted on views which are in the line of those first suggested by Lamarck, a phase of evolution which we have called Neolamarckianism. The authors to whom Mr. Spencer might have with good reason referred are, in Europe, Semper, Kölliker, Wagner, Martins, Plateau, Weismann, and Dohrn, and in this country Haldeman, Leidy, Wyman, Clark, Cope, Hyatt, Walsh, Allen, W. H. Edwards, Dall, and the writer.

[2] This point is one which the writer has also made and published over twelve years ago in a communication to the Nation, holding that it is an important objection to the theory of natural selection, the very nature of which involves the existence of a world already stocked with life forms. What the theory of evolution should explain is the origin of these first ordinal and class forms. Given even a scanty fauna, isolated members of different orders and classes, and it is comparatively easy to account for the origin of the later more numerous descendants.

Finally, Mr. Spencer makes the following important admission:—

"This general conclusion brings with it the thought that the phrases employed in discussing organic evolution, though convenient and indeed needful, are liable to mislead us by veiling the actual agencies. That which really goes on in every organism is the working together of component parts in ways conducing to the continuance of their combined actions in presence of things and actions outside, some of which tend to subserve and others to destroy the combination. The matters and forces in these two groups are the sole causes properly so called. The words 'natural selection' do not express a cause in the physical sense. They express a mode of co-operation among causes, or rather, to speak strictly, they express an effect of this mode of co-operation" (p. 40).

Here we have frankly intimated what the Neolamarckian has for years insisted on, that the phrase "natural selection" is not a *vera causa*, but rather expresses the results or effects of the co-operation of a number of factors in organic evolution. In the case of too many naturalists the dogma or creed of natural selection has, it seems to us, tied their hands, obscured their vision, and prevented their seeking by observation and experiment to discover, so far as human intelligence can do so, the tangible, genuine, efficient factors of organic evolution.

EDITORS' TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

The bringing into cultivation of the arid regions of the United States would increase the agricultural resources of the nation by one-third. The man who should devise a successful method of doing this would be one of the benefactors of his kind and country. The region to be thus reclaimed includes a wide strip extending north and south, east of the Rocky Mountains; a large part of the drainage basin of the Rio Grande; the hydrographic basin of the Great Colorado, and the Great Basin of Utah and Nevada. Small portions of all these regions are at present